# Exhibit 33

**IN THE UNITED STATES DISTRICT COURT**
**FOR THE DISTRICT OF COLORADO**

Civil Action No. 17-cv-1661-WJM-MEH
*Consolidated with* 17-cv-1679-WJM-MEH

SIERRA CLUB; ELYRIA AND SWANSEA NEIGHBORHOOD ASSOCIATION; CHAFFEE PARK NEIGHBORHOOD ASSOCIATION; and COLORADO LATINO FORUM,

Plaintiffs,

v.

FEDERAL HIGHWAY ADMINISTRATION, ELAINE CHAO, in her official capacity as Secretary of Transportation; and JOHN M. CARTER, in his official capacity as Division Administrator, Defendants,

v.

COLORADO DEPARTMENT OF TRANSPORTATION, and SHAILEN P. BHATT, in his official capacity as Executive Director of the Colorado Department of Transportation,

Defendant-Intervenors.

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EXHIBIT 33
SECOND DECLARATION OF DR. GREGORY ROWANGOULD
(Case No. 17-cv-1679-WJM-MEH)

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COUNSEL FOR PETITIONERS

# DECLARATION OF GREGORY ROWANGOULD

# RE: MODELING PM2.5 EMISSIONS FROM I-70

I, Gregory Rowangould, declare that the following is true and correct and within my personal knowledge.

1. If called as a witness, I could and would testify competently to the facts stated herein. As to those matters that reflect an opinion, they reflect my personal opinion and judgment on the matter based on the years of educational and professional experience shown in my curriculum vitae ("CV").

2. My CV is appended hereto as Attachment A.

3. I am a citizen of the United States, and reside in Albuquerque, New Mexico.

4. I am an Assistant Professor at the University of New Mexico in the Department of Civil Engineering. I specialize in the environmental and air quality impacts of transportation systems and facilities, including emissions from mobile sources and modeling their air quality impacts.

5. I am a Principle of Sustainable Systems Research, L.L.C., an environmental consulting firm in Davis, California.

6. I hold a Bachelor's of Science in chemical engineering from the University of Maine, a Master of Science in resource economics and policy from the University of Maine, and a Ph.D. in Civil and Environmental Engineering with concentration in Transportation from the University of California, Davis.

7. I have more than ten years experience in environmental research, teaching, and consulting. A substantial part of my work has related to air quality modeling and analysis of

urban transportation networks, transportation projects, including proposed highway projects.

8. I have performed consulting services for the U.S. Environmental Protection Agency with regard to research activities involving the modeling of air pollution from highways.

9. I have experience using both U.S. EPA's models for estimating emissions from motor vehicles (MOVES) and for estimating the concentrations of mobile sources emissions when they are released into the ambient air (AERMOD).

10. I have published reports of research projects in which I modeled emissions from highway traffic. These prior studies included entire urban roadway networks. The purpose of the modeling in these studies was to look at the air quality and health impacts of regional transportation plans, land-use policies, and most recently a port clean trucks program. All of the studies modeled $PM_{2.5}$. The studies using AERMOD and MOVES (or EMFAC in California) include the following:

- Dana, R., **G. Rowangould**, and D. Niemeier. (*in press*). *Evaluation of the Health Impacts of Rolling Back a Port Clean Trucks Program*. Transportation Research Record: Journal of the Transportation Research Board of the National Academies.
- Poorfakhraei, A., M. Tayarani, and **G. Rowangould**. (2017). *Evaluating Health Outcomes from Vehicle Emissions Exposure in the Long Range Regional Transportation Planning Process*. Journal of Transport & Health. 6: 501-515.
- Tayarani, M., A. Poorfakhraei, R. Nadafianshahamabadi, and **G. Rowangould**. (2016). Evaluating unintended outcomes of regional smart-growth strategies: Environmental justice and public health concerns. Transportation Research Part D: Transport and Environment 49, 280–290. doi:10.1016/j.trd.2016.10.011
- **Rowangould, G.** (2015). *A New Approach for Evaluating Regional Exposure to Particulate Matter Emissions from Motor Vehicles.* Transportation Research Part D: Transport and Environment. 34: 307-317.

11. My current research, funded by U.S. EPA, uses travel demand modeling, MOVES and AERMOD to evaluate exposure to $PM_{2.5}$ from vehicle traffic in Albuquerque, NM and Atlanta, GA.

12. I prepared the report entitled "Modeling $PM_{2.5}$ Emissions from Phase I of the I-70 East (Central 70) Project," incorporated herein and attached hereto as Attachment B.

13. I prepared this report in response to a request from the Colorado Latino Forum (CLF) that I perform an air quality modeling hot-spot analysis of emissions from the I-70 Project, Phase 1, to demonstrate whether Project emissions are likely to cause a violation of the 24-hour National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ in the neighborhoods adjacent to the I-70 Project.

14. The request for this analysis was prompted by concerns from nearby residents that Project emissions would likely cause a violation of the NAAQS based on the modeling of $PM_{10}$ performed for the conformity determination which concluded that Project emissions nearly violate the NAAQS for $PM_{10}$, that total emissions of both $PM_{10}$ and $PM_{2.5}$ are expected to increase over the life of the Project, and that EPA had found exposure to $PM_{2.5}$ to be much more strongly correlated with the mortality effects of exposure to PM. Residents were concerned about the likely impact on community health resulting from increased exposure to $PM_{2.5}$. CLF members suspected that the State and federal transportation agencies had not taken seriously the threats to community health when they declined to perform a scientifically grounded investigation of the likely impacts of Project $PM_{2.5}$ emissions.

15. The attached report describes the methods and procedures applied to perform the modeling analysis, and contains the results of my modeling analysis showing that emissions from the Project are likely to cause a violation of the 24-hour NAAQS for $PM_{2.5}$.

16. This modeling analysis was performed using the same emissions model (MOVES) and air quality model (AERMOD) required by EPA for modeling highway emissions, and

applies the same assumptions and inputs, with one exception described in the report, as those used by the Federal Highway Administration to model emissions of $PM_{10}$ from the Project for the conformity determination. I exercised no independent judgment regarding the estimation of traffic, traffic emissions, the use of meteorological data to model dispersion, or the selection of receptor locations for modeling expected future concentrations. I replicated as closely as possible the decisions made by FHWA in its modeling analysis of $PM_{10}$ to avoid any possible discrepancy with the procedures implemented by FHWA to model Project $PM_{10}$ emissions.

17. I used the data contained in the modeling files for the $PM_{10}$ hot-spot analysis provided by the Colorado Department of Transportation in response to a public comment requesting documentation of modeling files. The agency-supplied files were used to avoid any errors or variances that might arise from independently obtaining needed input data. The data files used are provided as an appendix to the report.

18. The results of my modeling analysis are contained in the attached report (Attachment B).

I declare pursuant to 28 U.S.C. § 1746, subject to the penalty of perjury under the laws of the United States, that the above stated facts, and the facts stated in the report attached hereto, incorporated herein and identified as Attachment B, are true and correct to the best of my knowledge and belief.

**Executed at Albuquerque, New Mexico, this 8 day of March, 2018.**

**Dr. Gregory Rowangould**

# Exhibit 33
# Attachment – A

# DR. GREGORY ROWANGOULD, PHD

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## EDUCATION

PhD **University of California**, Davis (2010)
*Civil and Environmental Engineering: concentration in Transportation*
Dissertation: "A Spatially Detailed Locomotive Emission Model and Goods Movement Data Constraints on Public Policy and Planning"

MS **University of Maine**, Orono (2006)
*Resource Economics and Policy: concentration in Environmental Economics*
Thesis: "A Spatial Analysis of Passenger Vehicle Attributes, Environmental Impact and Policy"

BS **University of Maine**, Orono (2003)
*Chemical Engineering*

## PROFESSIONAL EXPERIENCE

**University of New Mexico**, Albuquerque, NM (8/2012 – current)
*Assistant Professor,* Department of Civil Engineering
*Director of the New Mexico Local Technical Assistance Program*

**Sustainable Systems Research, LLC**, Davis, CA (5/2017 – current)
*Principle*

**Natural Resources Defense Council**, Santa Monica, CA (7/2010 – 7/2012)
*Transportation and Air Quality Science Fellow*

**University of California**, Davis, CA (9/2006 – 7/2010)
*Research Assistant,* Department of Civil & Environmental Engineering

**University of California**, Davis, CA (3/2009 – 6/2009)
*Teaching Assistant,* Department of Civil & Environmental Engineering (3/2010 – 6/2010)

**University of Maine**, Orono, ME (9/2004 – 8/2006)
*Research Assistant,* Department of Resource Economics & Policy and the Margaret Chase Smith Policy Center

## CONSULTING EXPERIENCE

**Freedman Boyd Hollander Goldberg Urias & Ward P.A.,** Albuquerque, NM (5/2016 – 8/2016)

**ICF Incorporated, LLC**, Fairfax, VA (5/2014 – 12/2014)
Provided consulting services to ICF for a Federal Highway Administration and Centers for Disease Control project to develop a community health risk tool. Project website and tool available at http://www.transportation.gov/transportation-health-tool/indicators

**United States Environmental Protection Agency**, Anne Arbor, MI. (11/2013 – 12/2013)
Provided a scientific review of a US EPA sponsored air quality research project

**Communities for a Better Environment**, Huntington Park, CA. (11/2011 – 8/2012)
Provided transportation planning and air quality consulting services to Communities for a Better Environment

**The Ride for Roswell**, Buffalo, NY (4/2011 – 6/2011)
Pro bono consulting, bicycle traffic modeling and planning for a charitable community bicycle ride

**Pew Center on Global Climate Change**, Washington, D.C. (12/2008 – 8/2009)
*Consultant,* developed a research report investigating the GHG mitigation potential for domestic and international marine shipping and aviation

## NATIONAL/REGIONAL/LOCAL SERVICE

**2017 International Cycling Safety Conference**, University of California, Davis, CA
*Member of the Scientific Committee and Session Chair* (9/20/2017-9/23/2017)

**Transportation and Air Quality Committee (ADC20)**, Transportation Research Board of the National Academies, Washington, D.C.
*Committee Member & Research Subcommittee Vice Chair* (5/2017 – current)
*Committee Member & Paper Review Co-Chair* (4/2014 – 4/2017)

**Transportation Research Part D: Transport and Environment (TRD)**, Elsevier Ltd.
*Member of the Editorial Board* (1/2017 – current)

**Transportation Research Board Annual Meeting Workshop,** Integrated Land-use, Travel Demand, Air Quality & Exposure Modeling: The Future of Regional Transportation Planning?
*Organizer, Co-Chair and Moderator* (1/11/2015)

**National Cooperative Highway Research Program**, Transportation Research Board of the National Academies, NCHRP Project 08-102 – Bicycle Facility Preferences and Effects on Increasing Bicycle Trips
*Panel Member* (10/2014 – current)

**Sustainable Cities and Society (SCS)**, Elsevier Ltd.
*Member of the Editorial Board* (10/2014 – 2/2018)
*Editor of Special Edition on Transportation* (2/1/2016 – 8/2017)

**Central New Mexico Climate Change Scenario Planning Project,** US Department of Transportation & Mid-Region Council of Governments
*Member, Mitigation Technical Committee* (11/2013 – 6/2014)

**Statewide Public Health, Safety, and Security Working Group**, New Mexico Department of Transportation
*Working Group Member* (11/2013 – 10/2015)

**Land-Use Transportation Integration Committee**, Mid-Region Council of Governments, Albuquerque, NM
*Committee Member* (12/2012 – 6/2014)

## AWARDS AND RECOGNITION

**Young Professional Runner-Up Best Paper Award**, Environmental Management Group, Air & Waste Management Association 108th Annual Conference, Raleigh, NC, June 25, 2015

**Best Paper Award**, Civil Engineering Department, University of New Mexico, Spring 2015 & Fall 2017

**Young Professional Best Paper Award**, Environmental Management Group, Air & Waste Management Association 107th Annual Conference, Long Beach, CA, June 25, 2014

## PEER REVIEWED JOURNAL PAPERS

**Rowangould, G**., R. Nadafianshahamabadi*, and A. Poorfakhraei*.(*in press*). *Programming Flexible Congestion Mitigation and Air Quality Program Funds: Best Practices for State DOTs*. Transportation Research Record: Journal of the Transportation Research Board of the National Academies.

Dana, R., **G. Rowangould**, and D. Niemeier. (*in press*). *Evaluation of the Health Impacts of Rolling Back a Port Clean Trucks Program*. Transportation Research Record: Journal of the Transportation Research Board of the National Academies.

Poorfakhraei, A*., M. Tayarani*, and **G. Rowangould**. (2017). *Evaluating Health Outcomes from Vehicle Emissions Exposure in the Long Range Regional Transportation Planning Process*. Journal of Transport & Health. 6: 501-515.

Nadafianshahamabadi, R*., M. Tayarani*, and **G. Rowangould.** (2017). *Differences in Expertise and Values: Comparing Community and Expert Assessments of a Transportation Project*. Sustainable Cities and Society. doi:10.1016/j.scs.2016.08.027

Tayarani, M*., A. Poorfakhraei*, R. Nadafianshahamabadi*, and **G. Rowangould**. (2016). Evaluating unintended outcomes of regional smart-growth strategies: Environmental justice and public health concerns. Transportation Research Part D: Transport and Environment 49, 280–290. doi:10.1016/j.trd.2016.10.011

**Rowangould, G**. and M. Tayarani* (2016). *The Effect of Bicycle Facilities on Travel Mode Choice Decisions*. ASCE Journal of Urban Planning and Development. doi: 10.1061/(ASCE)UP.1943-5444.0000341

Poorfakhraei, A.* and **G. Rowangould** (2015). *Estimating Welfare Change Associated with Improvements in Urban Bicycling Facilities.* ASCE Journal of Transportation Engineering. 141(11): 04015025.

**Rowangould, G.** (2015). *A New Approach for Evaluating Regional Exposure to Particulate Matter Emissions from Motor Vehicles*. Transportation Research Part D: Transport and Environment. 34: 307-317.

**Rowangould, G.** (2013). *Public Financing of Private Freight Rail Infrastructure to Reduce Highway Congestion: A Case Study of Public Policy and Decision Making in the United States*. Transportation Research Part A: Policy and Practice. 57: 25-36.

**Rowangould, G.** (2013). *A Census of the United States Near-Roadway Population: Public Health and Environmental Justice Considerations*. Transportation Research Part D: Transport and Environment. 2: 59-67.

**Gould, G.** and D. Niemeier (2011). *Assignment of Emissions Using a New Locomotive Emissions Model.* Environmental Science and Technology. 45(13): 5846- 5852.

**Gould, G**. and A. Karner (2009). *Modeling Bicycle Facility Operation: a Cellular Automaton Approach.* Transportation Research Record: Journal of the Transportation Research Board of National Academies. 2140: 157-164.

**Gould, G.** and D. Niemeier (2009). *Review of Regional Locomotive Emission Modeling and the Constraints Posed by Activity Data*. Transportation Research Record: Journal of the Transportation Research Board of the National Academies. 2117: 24-32.

Niemeier, D., **G. Gould,** A. Karner, M. Hixson, B. Bachmann, C. Okma, Z. Lang and D. Heres Del Valle (2008). *Rethinking downstream regulation: California's opportunity to engage households in reducing greenhouse gases.* Energy Policy, 36(9)

*****Students advised by Dr. Rowangould

## PEER REVIEWED CONFERENCE PAPERS

Montano, S*. and **G. Rowangould**. (January 9th, 2018). *Evaluating the Role of Federal Transportation Funding Flexibility and Investments in Bicycle and Pedestrian Infrastructure.* Presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.

Mohammad, T*., R. Nadafianshahamabadi*, A. Poorfakhraei* and **G. Rowangould.** (January 9th, 2018). *Evaluating the Cumulative Air Quality Impacts of a Long Range Regional Transportation Plan.* Presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.

**Rowangould, G**., R. Nadafianshahamabadi, and A. Poorfakhraei*. (January 9th, 2018). *Programming Flexible Congestion Mitigation and Air Quality Program Funds: Best Practices for State DOTs.* Presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.

Dana, R., **G. Rowangould**, and D. Niemeier. (January 8th, 2018). *Evaluation of the Health Impacts of Rolling Back a Port Clean Trucks Program*. Presentation at the Transportation Research Board 97th Annual Meeting, Washington, D.C.

Nadafianshahamabadi, R.* and **G. Rowangould** (January 10, 2017). *Evaluating Sustainability in Transportation Plans: Review of Long-Range Transportation Plans in the United States.* Presentation at the Transportation Research Board 96th Annual Meeting, Washington, D.C.

Tayarani. M*, A. Poorfakhraei* and **G. Rowangould** (January 10, 2017). *Can Regional Transportation and Land-Use Planning Reduce GHG Emissions?* Presentation at the Transportation Research Board 96th Annual Meeting, Washington, D.C.

Rodriguez, M.* and **G. Rowangould** (January 11, 2017). *The Current State of Sidewalk ADA Compliance and Alternative Funding Methods for Albuquerque, NM.* Presentation at the Transportation Research Board 96th Annual Meeting, Washington, D.C.

Tayarani. M*, A. Poorfakhraei*, and **Rowangould, G.** (August 4, 2016). *Can Regional Transportation and Land-Use Planning Reduce GHG Emissions?* Presented at the Transportation Research Board Summer Conference on Transportation Planning and Air Quality, Minneapolis, MN.

Tayarani. M*, A. Poorfakhraei*, and **Rowangould, G.** (August 5, 2016). *Quantifying the Air Quality & Congestion Benefits of Bicycle Facilities.* Presented at the Transportation Research Board Summer Conference on Transportation Planning and Air Quality, Minneapolis, MN.

Nadafianshahamabadi, R.*, M. Tayarani*, and **G. Rowangould** (January 12, 2016). *Differences in Expertise and Values: Comparing Community and Expert Assessments of a Transportation Project.* Presentation at the Transportation Research Board 95th Annual Meeting, Washington, D.C.

Moreno, S. A.*, R. R. Gade*, and **G. Rowangould** (January 13, 2016). *Investigating Pedestrian Crash Risk in Albuquerque, New Mexico*. Presentation at the Transportation Research Board 95th Annual Meeting, Washington, D.C.

Tayarani, M.*, A. Poorfakhraei*, R. Nadafianshahamabadi*, and **G. Rowangould** (January13, 2016). *Large-Scale, High-Resolution Air Quality Modeling Framework to Evaluate Environmental Justice in Long-Range Transportation Planning*. Presentation at the Transportation Research Board 95th Annual Meeting, Washington, D.C.

Poorfakhraei, A.*, and **G. Rowangould** (January 11, 2016) Evaluating Mobile-Source Air Pollution *Exposure, Equity, and Health Risks in Long-Range Regional Transportation Plans*. Presentation at the Transportation Research Board 95th Annual Meeting, Washington, D.C.

**Rowangould, G**., A. Poorfakhraei*, and M. Tayarani* (June 24, 2015). *A New Approach for Evaluating Regional Exposure to Particulate Matter Emissions from Motor Vehicles.* Presented at the Air & Waste Management Association Annual Conference, Raleigh, NC

Poorfakhraei, A.* and **G. Rowangould** (January 14, 2015). *Economic Valuation of Improvements in Urban Cycling Facilities*. Presented at the Transportation Research Board 94th Annual Meeting, Washington, D.C.

**Rowangould, G.** and M. Tayarani* (January 12, 2015). *The Effect of Bicycle Paths on the Decision to Commute by Bicycle.* Presented at the Transportation Research Board 94th Annual Meeting, Washington, D.C.

Tayarani, M.* and **G. Rowangould** (January 12, 2015). *Quantifying the Air Quality and CongestionBenefits of Bicycle Facilities: A Case Study from Albuquerque New Mexico.* Presented at the Transportation Research Board 94th Annual Meeting, Washington, D.C.

**Rowangould, G.** (March 3, 2014). *Using AERMOD for Regional Transportation Planning: Exposure Analysis, Environmental Justice, and Pro-Active Hot-spot Analysis.* Presented at the Transportation, Land Use Planning, and Air Quality Conference, Charlotte, NC

**Rowangould, G.** (June 25, 2014). *Regional Long Range Transportation Plan Air Quality and Exposure Analysis*. Presented at the Air & Waste Management Association 107th Annual Conference, Long Beach, CA

**Rowangould, G.** and J. Luna (January 2014). *Does Dedicated Bicycle Infrastructure Reduce Motorized Vehicle Trips? Results from the Albuquerque Bicycle Travel Study.* Presented at the Transportation Research Board 93rd Annual Meeting, Washington, D.C.

**Gould, G.** and S. Contreras* (January 15, 2013). *Regional Scale Dispersion Modeling and Analysis of Directly Emitted Fine Particulate Matter from Highway Vehicles Using AERMOD.* Presented at the Transportation Research Board 92nd Annual Meeting, Washington, D.C.

**Gould, G.** (January 15, 2013). *A Census of the U.S. Near Roadway Population: Particulate Matter Exposure, Environmental Justice, and Coverage of the Air Quality Monitoring Network*. Presented at the transportation Research Board 92nd Annual Meeting, Washington, D.C.

**Gould, G**. and D. Niemeier (January 12, 2010). *A Geographically Detailed Locomotive Emission Model.* Presented at the Transportation Research Board 89th Annual Meeting, Washington, D.C.

**Gould, G**. and A. Karner (January 14, 2009). *Modeling Bicycle Facility Operation: a Cellular Automaton Approach.* Presented at the Transportation Research Board 88th Annual Meeting, Washington, D.C.

**Gould, G**. and D. Niemeier (January 12, 2009). *Review of Regional Locomotive Emission Modeling and the Constraints Posed by Activity Data.* Presented at the Transportation Research Board 88th Annual Meeting, Washington, D.C.

*****Students advised by Dr. Rowangould

## PEER REVIEWED REPORTS AND OTHER PUBLICATIONS

McCollum, D., **G. Gould,** and D. Greene (2009). *Greenhouse Gas Emissions from Aviation and Marine Transportation: Mitigation Potential and Policies.* Report prepared for the Pew Center on Global Climate Change, Washington D.C.

## OTHER REPORTS AND PUBLICATIONS

**Rowangould**, G., R. Nadafianshahamabadi*, A. Poorfakhraei*, S. Bogus Halter (May 2017) *Congestion Mitigation and Air Quality Program Best Practices Scan, Final Report.* Report prepared by the University of New Mexico for the New Mexico Department of Transportation, Santa Fe, New Mexico.

*Futures 2040: Metropolitan Transportation Plan,* Mid Region Council of Governments, Albuquerque, NM. (**G. Rowangould** was one of many contributors and co-authors, provided technical assistance for travel demand modeling and vehicle emission modeling)

**Rowangould, G.**, M. Tayarani*, and A. Poorafakhraei* (April, 2015). *Futures 2040: Metropolitan Transportation Plan - Appendix F: GHG Emissions Reduction Strategies*, Mid Region Council of Governments, Albuquerque, NM.

Lee, S., Tremble, M. Vaivai, J., **Rowangould, G**., Tayarani, M.*, Poorfakhraei, A.* (March, 2015). *Central New Mexico climate change scenario planning project: final report.* Report prepared for the U.S. Department of Transportation, U.S. Federal Highway Administration and Mid Region Council of Governments.

Lee, S., M. Tremble, J. Vaivai, Herrington, C., R. Gonzalez-Pinzon, M. Stone, and **G. Rowangould** (December, 2014). *Climate Change Effects on Central New Mexico's Land Use, Transportation System and Key Natural Resources.* Report prepared by Ecosystem Management Inc. and the University of New Mexico for the U.S. Department of Transportation VOLPE Center, Cambridge, MA

**Rowangould, G.,** M. Tayarani*, and A. Poorafakhraei* (November, 2014) *Central New Mexico Climate Change Scenario Planning Project: Analysis of Additional Greenhouse Gas Mitigation Strategies.* Report prepared by the University of New Mexico for the U.S. Department of Transportation VOLPE Center, Cambridge, MA

Lee, S., M. Tremble, J. Vaivai, Herrington, C., R. Gonzalez-Pinzon, M. Stone, and **G. Rowangould** (May 2014) *Climate Change Resilience of Land Use, Transportation and Key Natural Resources in Central New Mexico.*

Report prepared by Ecosystem Management Inc., Sustainable Systems Research LLC. and the University of New Mexico for the U.S. Department of Transportation VOLPE Center, Cambridge, MA

**Gould, G.** (2012) *Analysis of Greenhouse Gas Emission Estimates for the Interstate 710 Corridor Project*. Report Prepared for Communities for a Better Environment, Huntington Park, CA.

**Gould, G.** (2012) *Analysis of the Alternatives Selection Process for the Interstate 710 Corridor Project*. Report Prepared for Communities for a Better Environment, Huntington Park, CA.

**Gould, G.** (2012) *Physical Separation of the Chicago Area Waterway System: The Economic and Environmental Impact of Barge Traffic Disruption*. NRDC Working Paper.

C. Noblet, **G. Gould**, J. Rubin, D. Innis, and C. Morris (2006). *Sustainable Transportation Funding for Maine's Future*. Report prepared for the Maine Department of Transportation, Augusta, ME.

*****Students advised by Dr. Rowangould

# Exhibit 33
# Attachment – B

# Modeling PM2.5 Emissions from Phase I of the I-70 East (Central 70) Project

March 8, 2018

Prepared by:

Dr. Gregory Rowangould, PhD
Sustainable Systems Research, LLC

## EXECUTIVE SUMMARY

### E1 Background

Two detailed air quality modeling studies were performed for the Record of Decision[1] to determine the impact that I-70 East Phase 1 (Central 70) Project ("Project") emissions are expected to have on future ambient concentrations of Carbon Monoxide and $PM_{10}$. Those "hot-spot" analyses[2] were performed to satisfy the conformity criteria under section 176(c) of the Clean Air Act which require that emissions from a transportation Project not cause or contribute to a violation of any NAAQS. 42 U.S.C. §7506(c)(1)(B); 40 C.F.R. §93.116. Projects located in an area designated nonattainment, or redesignated as attainment and required to have a maintenance plan pursuant to section 175A, must demonstrate conformity to qualify for federal funding. 42 U.S.C. §7506(c)(1), (c)(5). FHWA determined that the Project was required to demonstrate conformity with the NAAQS for Carbon Monoxide and $PM_{10}$ under section 176(c) because Denver had previously been designated nonattainment for those pollutants.

FHWA did not apply EPA prescribed modeling procedures to evaluate the impacts that Project $PM_{2.5}$ emissions would be expected to have on ambient air quality in the Project area. FHWA explained that an emissions analysis was not performed because a Clean Air Act conformity determination is not required for $PM_{2.5}$.

Members of Denver's City Council, community organizations representing neighborhoods adjacent to the Project and the Sierra Club in comments on the Supplemental Draft EIS and on the Final EIS specifically requested that modeling be performed to determine by how much $PM_{2.5}$ emissions attributable to the Project would increase the ambient concentrations of $PM_{2.5}$ in the Project area, and the potential for emissions from the Project to cause or contribute to an exceedance of the $PM_{2.5}$ NAAQS.

The Sierra Club commented that under NEPA a quantitative hot-spot analysis is required because "the decisionmaker needs to know, and must disclose to the public, how much the increase in traffic between now and 2035 can be expected to worsen $PM_{2.5}$ exposures in the neighborhoods surrounding the Mousetrap. If the Project will exacerbate exceedances of the standard set to protect public health, the Colorado and Denver regional air quality planning agencies need to know so they can begin to develop a control strategy, taxpayers need to know because they will incur additional costs to control CDOT's pollution, and the public needs to know so they can decide whether to take action to protect themselves and their families from dangerous pollution levels."[3] The Club requested a scientifically credible analysis to determine if the Project would violate the NAAQS or contribute to adverse health impacts. The Club commented that a modeling analysis consistent with EPA's hot-spot analysis modeling procedures are required to "satisfy the requirement that an EIS 'shall state how alternatives … will or will not achieve the requirements of … other environmental laws and policies,' 40 CFR § 1502.2(d). The analysis for $PM_{10}$ and CO apply the methodologies prescribed by EPA in its Quantitative Guidance for making project-level conformity determinations. Those methodologies should be applied to assess the likely impacts of $PM_{2.5}$ and $NO_2$ emissions as well."[4]

FHWA rejected these requests. Modeling for $PM_{2.5}$ was not performed as part of the NEPA process. FHWA described no other methodology for determining whether Project emissions would cause or contribute to violations of the NAAQS, and if so, determine the mitigation measures that would be necessary to achieve

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[1] *I-70 East ROD 1: Phase 1 (Central 70 Project), Attachment C7, Air Quality Conformity Technical Report* (January 2017),

[2] "*Hot-spot analysis* is an estimation of likely future localized CO, $PM_{10}$, and/or $PM_{2.5}$ pollutant concentrations and a comparison of those concentrations to the national ambient air quality standards. Hot-spot analysis assesses impacts on a scale smaller than the entire nonattainment or maintenance area, including, for example, congested roadway intersections and highways or transit terminals, and uses an air quality dispersion model to determine the effects of emissions on air quality." 40 C.F.R. §93.101 "Definitions."

[3] "Sierra Club Comments I-70 FEIS," Record of Decision, Attachment E, p. 110.

[4] "I-70 East EIS – DEIS COMMENTS," submitted by Sierra Club. FEIS, Attachment Q, p. S-121.

emission reductions sufficient to avoid such violations. FHWA also applied no alternative methodology to quantify increased community exposure to $PM_{2.5}$ to estimate impacts on community health.

The Colorado Latino Forum employed the services of Sustainable Systems Research ("SSR") to perform this modeling to address these community concerns.

### E2 Factors Supporting the Need for Analysis of Air Quality and Health Impacts.

A number of factors suggest the need for a modeling analysis of $PM_{2.5}$ including the more severe impact that fine particles have on human health, the extremely narrow margin for attainment of the NAAQS for $PM_{10}$, the large fraction of $PM_{10}$ emissions from the Project that the agencies reported are $PM_{2.5}$, and the lower concentrations allowed in the ambient air by the NAAQS for $PM_{2.5}$ compared to $PM_{10}$. Particle pollution from the Project is produced from vehicle exhaust, vehicle brake and tire wear, and re-suspended road dust from vehicle traffic. Each of these emissions sources emit particles that fall within the $PM_{10}$ and $PM_{2.5}$ size ranges. Therefore, higher $PM_{10}$ emission rates are generally associated with higher $PM_{2.5}$ emission rates. High concentrations of and significant increases in exposure to $PM_{10}$ therefore raised concerns about $PM_{2.5}$ concentrations and exposures.

#### *E2.1 Modeling for PM10*

Community concern about possible significant impacts from increased future concentrations of $PM_{2.5}$ were prompted by 1) the increase in tailpipe $PM_{2.5}$ emissions between 2025 and 2035 reported in the Final EIS,[5] 2) the large 43% increase in expected road dust emissions between 2010 and 2035,[6] and the emissions analysis performed for $PM_{10}$ which showed that $PM_{10}$ emissions attributable to the Project will add more than 41 $\mu g/m^3$ to background concentrations of 113 $\mu g/m^3$. Ambient $PM_{10}$ concentration in the study area would equal 154.136 $\mu g/m^3$. However, since EPA's design value rule require rounding $PM_{10}$ estimates to the nearest 10 $\mu g/m^3$,[7] the design value (the concentration estimate used for determining compliance with the NAAQS) is 150 $\mu g/m^3$. The 24-hour $PM_{10}$ NAAQS is 150 $\mu g/m^3$. Had the estimated $PM_{10}$ concentrations been just 0.864 $\mu g/m^3$ higher (an increase of just 0.56%) the Project's contribution to background $PM_{10}$ concentrations would have resulted in a design value that exceeds the $PM_{10}$ NAAQS.

#### *E2.2 More Protective NAAQS for $PM_{2.5}$*

$PM_{10}$, referred to as "coarse" particles and $PM_{2.5}$, referred to as "fine" particles, are both particle air pollution[8] that differ by particle size. $PM_{10}$ pollution includes respirable particles defined as having a diameter $\leq$ 10 µm, while $PM_{2.5}$ pollution includes inhalable particles defined as having a diameter $\leq$ 2.5 µm. $PM_{2.5}$ is therefore a subset of $PM_{10}$. EPA initially established standards for $PM_{10}$ in 1987, but promulgated separate standards for $PM_{2.5}$ in 1997 when it determined that "fine particles are a better surrogate for those particle components linked to mortality and morbidity effects at levels below the current [$PM_{10}$] standards."[9] As a result, EPA decided "to provide additional protection against the risk posed by PM by adding new standards for the fine fraction of $PM_{10}$, as opposed to tightening the current $PM_{10}$ standards."[10] As a result the 24-hour NAAQS limits $PM_{2.5}$ to 35 $\mu g/m^3$ compared to 150 $\mu g/m^3$ for $PM_{10}$.[11] The Project's marginal attainment of the $PM_{10}$ NAAQS suggested a high probability that the more protective NAAQS for $PM_{2.5}$ could be violated.

The slim margin by which the Project avoids exceeding the $PM_{10}$ NAAQS, and the significant increase in community exposures to PM that would result, suggested that the EPA-approved modeling procedure used

[5] FEIS, Air Quality Technical Report, Table 22 "PM2.5 emission inventories (tons per day)," p. 84 (January 2016).
[6] *Id.*, § 7.4.9, p. 109.
[7] 40 C.F.R. § 50.6, Appendix K.
[8] "National Ambient Air Quality Standards for Particulate Matter; Final Rule," 78 Fed. Reg. 3086 (January 15, 2013).
[9] "National Ambient Air Quality Standards for Particulate Matter; Final Rule," 62 Fed. Reg. 38,651, 38,665 (July 18, 1997).
[10] *Id.*
[11] *See* 40 C.F.R. §§ 50.6 [$PM_{10}$], 50.13 [$PM_{2.5}$].

to estimate future $PM_{10}$ concentrations should also be applied to determine expected effects that Project $PM_{2.5}$ emissions would have on future $PM_{2.5}$ concentrations to determine Project impacts on attainment of the NAAQS and resident health.

**E3 Summary of Results.**

The modeling performed for this analysis used the same EPA-required model for estimating vehicle emissions (MOVES) and the same EPA-approved model for estimating ambient air concentrations (AERMOD) used by FHWA to model ambient air concentrations for $PM_{10}$. The same traffic projections were used to estimate emissions, and the same meteorological conditions were used to model the dispersion of emissions in the ambient air. Modeling results were obtained to estimate ambient concentrations for $PM_{2.5}$ at the same receptor locations that were selected by FHWA to model Project $PM_{10}$ emissions.

Modeled concentrations attributable to Project emissions were added to monitored background concentrations of $PM_{2.5}$ to calculate the "design value" for the Project. The "design value" is the statistic that EPA requires to compare Project air quality with the NAAQS.

Background air quality for $PM_{2.5}$ measured at the same location selected by FHWA to represent background $PM_{10}$ air quality for the Project is 25 $\mu g/m^3$. Together the modeled future Project concentrations and monitored background concentration were used to calculate "design values" using the procedures prescribed in section 9.3.3 of both the 2010 and 2015 versions of EPA's Hot-spot guidance. [12,13]

Using the procedure described in EPA's 2010 Guidance, the Project contribution is 14.6 $\mu g/m^3$, which under EPA's rounding convention is treated as 15 $\mu g/m^3$. When added to background the design value is 40 $\mu g/m^3$.

Using the procedure in EPA's 2015 Guidance, the modeled Project contribution is 11.6 $\mu g/m^3$ which is rounded to 12 $\mu g/m^3$. When added to background, the design value is 37 $\mu g/m^3$.

The 24-hour NAAQS for $PM_{2.5}$ is 35 $\mu g/m^3$. Regardless which design value procedure is applied, the analysis establishes that Project emissions are expected to violate the NAAQS. The major difference between the two procedures is the magnitude of emission reduction needed to demonstrate compliance with the NAAQS.

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[12] *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas* (EPA 420-B-10-040) [hereinafter "2010 Hot-spot Guidance"]. 75 Fed. Reg. 79,370 (Dec.20, 2010).

[13] *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas*, (EPA-420-15-084) available at: https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100NMXM.pdf.

## 1 INTRODUCTION

The purpose of the air quality analysis reported in this document is to evaluate impacts on ambient air quality in the Project study area. This analysis reports results obtained from air quality modeling procedures prescribed by U.S. EPA to determine the impact that emissions of $PM_{2.5}$ from Phase 1 of the Project would be expected to have on future ambient concentrations of $PM_{2.5}$ in the Project study area. These modeled expected future concentrations provide the data required by EPA guidance to determine if Project emissions are likely to cause or contribute to a violation of the 24-hour NAAQS for $PM_{2.5}$. 40 C.F.R. §50.13. In addition, these modeling results provide information needed to determine whether Project emissions will contribute to an increase in community exposure to $PM_{2.5}$ that would likely cause a significant increase in adverse health outcomes known to be caused by exposure to $PM_{2.5}$.

## 2 DATA SOURCES AND ANALYSIS PROCEDURES

Conformity of the Project with the $PM_{10}$ NAAQS was evaluated by applying methodologies that generally appeared[14] to follow US EPA emission analysis guidelines for PM. In this study, SSR modeled the ambient concentration of $PM_{2.5}$ attributable to the Project using the methods, data preparation, and modeling assumptions prescribed by EPA's guidance for determining conformity with the NAAQS for $PM_{2.5}$.

SSR's analysis replicates for $PM_{2.5}$ emissions the modeling analysis performed for $PM_{10}$. We use the vehicle emission factors for $PM_{2.5}$ obtained from EPA's MOVES model for the same traffic data, and air dispersion modeling inputs to estimate $PM_{2.5}$ emissions and their ambient concentration within the study area as were used in the hot-spot emissions analysis for $PM_{10}$. This section provides an overview of the $PM_{10}$ modeling approach and then describes the changes SSR made to model $PM_{2.5}$ rather than $PM_{10}$.

### 2.1 Overview of Modeling Approach

There are four main steps to the agency's $PM_{10}$ hot-spot conformity analysis[15]. The same steps are also required for a $PM_{2.5}$ hotspot analysis. The following provides an overview of each step of the agency's $PM_{10}$ hot-spot analysis and the data it requires.

#### *2.1.1 Estimate Vehicle Traffic*

The first step is estimating vehicle traffic volumes and speeds on the roadways affected by the Project at a point in time when the maximum emission rates are expected. For the $PM_{10}$ analysis, the agencies determined that maximum $PM_{10}$ emissions from vehicle traffic would occur in the year 2040. The Denver Regional Council of Governments' (DRCOG) FOCUS 2040 travel demand model was then used to forecast traffic volumes and speeds on roadways across the Denver metropolitan region for a scenario where the I-70 East Project was implemented. Traffic outputs for travel on I-25, I-225 and I-70 and their on and off ramps near the I-25/I-70 and I-225/I-70 interchanges were extracted and used for the remainder of the air quality analysis. Traffic on other nearby roadways such as arterials, collectors and residential streets were not included.

#### *2.1.2 Estimate Vehicle Emissions*

In this step, emissions for $PM_{10}$ were estimated using emission rates from vehicle traffic on the roadways selected above. Emissions from vehicle exhaust, tire and brake wear, and re-suspended roadway dust were included. These estimates were then formatted as a series of adjacent "volume sources" which is one method outlined in the US EPA conformity guidance for defining emissions from a roadway in the AERMOD air

[14] As discussed later in this report, CDOT removed seven receptors from their main modeling files and completed the modeling for these receptors in separate modeling runs – one for each receptor. The modeling for these seven receptors contained altered emission source dispersion parameters. SSR has not seen this procedure used in other modeling applications, and has not found US EPA guidance authorizing such a procedure.

[15] Colorado Department of Transportation (January 2016), *I-70 East Final Environmental Impact Statement: Air Quality Technical Report*. As updated by the , *I-70 East ROD 1: Phase 1 (Central 70 Project) Air Quality Conformity Technical Report* (January 2017).

quality model that that was used by CDOT. Traffic data from the FOCUS 2040 model were available for 11 daily time periods, and so emission rates were estimated separately for each roadway segment for each time period.[16]

$PM_{10}$ emissions from vehicle exhaust, tire wear and brake wear were estimated using US EPA's Motor Vehicle Simulator ("MOVES") model. The MOVES model was used by the agencies to create an emission factor look-up table. The look-up table records outputs from the MOVES model of per-vehicle-mile $PM_{10}$ emissions by one-mile-per-hour increments of speed and one-percent increments of roadway grade for each roadway type (either controlled urban restricted access or urban unrestricted access in this case). The MOVES model was also updated with information about the Denver area vehicle fleet (e.g., distribution of vehicle ages and types), inspection and maintenance programs, and fuel properties by CDOT. The look-up table is then used to assign the appropriate emission rate to traffic on each roadway segment based on each segment's roadway type, grade and estimated speed. The quantity of emissions for each roadway segment for each time period is then calculated by multiplying the emission rate by the segment's traffic volume and distance. The same look-up table was used for SSR's $PM_{2.5}$ analysis, but the emission factors for $PM_{2.5}$ were applied.

MOVES does not estimate emissions from re-suspended roadway dust, so the agencies used emission factors developed for a recent $PM_{10}$ maintenance conformity study[17]. The roadway dust emission factors appear to follow US EPA guidelines for fugitive dust described in AP-42[18] with adjustments made for the region's conformity commitments[19]. A table of per-vehicle-mile emission factors for different types of roadways and for different parts of the Denver metropolitan region were developed (see Appendix A). The roadway dust emission factors are assigned to each roadway link based on the roadway type ("general freeway", "freeway HOT or managed lanes", or "ramps") and region (in this case "urban"). The quantity of re-suspended dust emissions for each roadway segment for each time period is then calculated by multiplying the emission factor by the segment's traffic volume and distance. The vehicle emissions from MOVES and the roadway dust emissions are then added together to estimate total emissions from the Project.

The final step in this part of the analysis is formatting the Project emission estimates for input to the AERMOD air quality model. There are two options for representing a roadway in AERMOD: as a series of adjacent area sources or volume sources. The agencies chose the volume source approach in which each roadway segment is represented as a series of evenly spaced volumes (e.g., cubes). The total emissions for each time period for each roadway segment are then evenly divided into the volume sources representing each roadway segment. The same procedure was used for SSR's $PM_{2.5}$ analysis.

### *2.1.3 Air Dispersion Modeling*

Air dispersion modeling is used to estimate the ambient concentration of vehicle emissions in the Project area. Emission rates are provided from the above emission modeling. The agencies used US EPA's AERMOD dispersion modeling (version 15181) for this step. In addition to defining the volume sources, AERMOD also requires several other inputs and parameter settings including a five year record (per conformity guidelines) or hourly meteorological data for the region, the population of the urban area being modeled (this is used to estimate the magnitude of the urban heat island which affects the dispersion

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[16] The Sierra Club submitted a comment objecting to the use of truck traffic estimated using the DRCOG model because the model predicted truck traffic that was 50% less than the share of total traffic actually reported by CDOT traffic counters. That issue is not addressed in this modeling analysis. For the purpose of this analysis, the traffic estimates used by the agencies for the $PM_{10}$ analysis are used for $PM_{2.5}$.

[17] Page 33, Colorado Department of Transportation (January 2016), *I-70 East Final Environmental Impact Statement: Air Quality Technical Report*.

[18] Chapter 13, Section 2.1, of US EPA, *AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*.

[19] This is based on a statement provided in the MS Excel sheet that provides the road dust emission factors and their calculation methodology. How the reductions for the conformity measure were estimated is not explained.

modeling), and the location of "receptors" (i.e., discrete points where the model will estimate emission concentrations ). SSR's $PM_{2.5}$ analysis used the same model, meteorological inputs and receptor locations.

CDOT used hourly meteorological data from the Stapleton Airport based on consultation with the Air Pollution Control Division of the Colorado Department of Public Health & Environment for the years 1990 to 1994[20]. Two networks of receptors were then defined for the study area. A series of closely spaced receptors (25 m) along the public right-of-way (typically the fence line) of each highway extending out 100 m and then a series of more widely spaced receptors (100 m) covering the remainder of the study area. The closely spaced receptors capture the rapidly changing concentration levels near the emission sources where the maximum emission concentration are most likely to be found.

There are also parameters that determine how AERMOD will aggregate and report the modeling results. By indicating the type of pollutant being modeled, AERMOD will generate an aggregated concentration estimate for each receptor that can be used for estimating a design value. For $PM_{10}$, AERMOD reports the sixth highest 24-hour concentration over a period of five years.

#### *2.1.4 Calculate Design Values*

The maximum $PM_{10}$ concentration from the AERMOD modeling is added to an estimate of the study area's background ambient $PM_{10}$ concentration to calculate a design value that EPA requires be used to compare Project emissions with the NAAQS.[21] Background concentrations were obtained from a nearby ambient air quality monitor located near Alsup Elementary School by the intersection of state highway 224 and I-76. Design values were estimated from monitoring data collected for 2012, 2013 and 2014.

### 2.2 Modeling $PM_{2.5}$

SSR replicated the agencies' $PM_{10}$ modeling approach as closely as possible to evaluate the expected future concentration of $PM_{2.5}$ emissions. Modeling $PM_{2.5}$ rather than $PM_{10}$ required changing several model parameter settings in the MOVES and AERMOD models. This section describes the data obtained from CDOT that were used for the $PM_{2.5}$ analysis and changes SSR made to these data and model parameter settings to estimate $PM_{2.5}$ rather than $PM_{10}$.

#### *2.2.1 Data from CDOT*

Data from several separate requests to CDOT were used to perform the modeling described in this section. Each of the data sets requested are data used in the agencies' $PM_{10}$ hot-spot analysis:

- Year 2040 traffic outputs from the DRCOG FOCUS model for Phase I of the I-70 East Project. These data were used by the agencies along with MOVES to estimate emission rates. Included are traffic volumes and speeds for 11 daily time periods for each Project area roadway segment. The data were provided as a series of Microsoft Excel files, one for each time period. (provided to SSR by CDOT on 9/18/2017).
- Geographical information system (GIS) files that define the roadway network (geographical position and length of each segment). The network data also contain information about the number of lanes and grade for each segment. The data were provided as ArcGIS shapefiles. (provided to SSR by CDOT on 9/18/2017)
- US EPA MOVES modeling files for the year 2040 that were used in the agencies' hot-spot analysis. These files included MySQL database tables that define MOVES model inputs that represent vehicle travel, the vehicle fleet and fuel properties for the Denver metropolitan region. The files also include MOVES input run specification files that define the parameter settings and model runs

[20] Page 41, Colorado Department of Transportation (January 2016), *I-70 East Final Environmental Impact Statement: Air Quality Technical Report*.

[21] The level of the national primary and secondary 24-hour ambient air quality standards for particulate matter is 150 micrograms per cubic meter (µg/m3), 24-hour average concentration. The standards are attained when the expected number of days per calendar year with a 24-hour average concentration above 150 µg/m3, as determined in accordance with appendix K to this part, is equal to or less than one. 40 C.F.R. §50.6(a).

used to create the $PM_{10}$ emission rate look-up tables that were used by the agencies. (provided to the Sierra Club by CDOT and made available to SSR)

- Re-suspended roadway dust emission factors for $PM_{10}$ that were used in the agencies' hot-spot analysis. Provided as an MS Excel file. (provided to the Sierra Club by CDOT and made available to SSR)
- US EPA AERMOD input and output files that were used in the agencies' hot-spot analysis for Phase I of the I-70 East Project. The input file defines all[22] inputs and parameter settings required to run AERMOD and produce the $PM_{10}$ design value estimates at each receptor location. The input files include the location of each volume source and receptor location (x and y UTM coordinates), the parameter values defining the size and shape of each volume source and its initial dispersion parameters, and emission rates that correspond to each volume source for each time period modeled. The AERMOD output files include the estimated sixth highest concentration of $PM_{10}$ at each receptor location[23].(provided to the Sierra Club by CDOT and made available to SSR)

Meteorological data for the years 1990 – 1994 for Stapleton Airport were provided to SSR by the Air Pollution Control Division of the Colorado Department of Public Health and Environment on 8/7/2017. These data contain hourly surface and upper air meteorological data processed for use in AERMOD.

#### *2.2.2 Changes Required to Model $PM_{2.5}$*

The main changes to the data and input files provided by CDOT that are required to model $PM_{2.5}$ are instructing MOVES to estimate $PM_{2.5}$ rather than $PM_{10}$, estimate $PM_{2.5}$ re-suspended dust emission factors, editing the AERMOD input files to replace $PM_{10}$ emission rates with $PM_{2.5}$ emission rates and instructing AERMOD to provide output for the eight highest (98$^{th}$ percentile) 24-hour concentrations as required for estimating $PM_{2.5}$ design values.[24]

The first step in SSR's analysis was running the MOVES model with the inputs provided by CDOT to create a $PM_{2.5}$ emission factor look-up table. We edited the MOVES run specification files so that they instructed MOVES to estimate $PM_{2.5}$ emissions rather than $PM_{10}$. All other MOVES run specifications and MySQL database tables were unchanged from the files provided by CDOT.

We then estimated the total quantity of $PM_{2.5}$ emissions for each roadway segment for each time period. This step required first matching traffic outputs from DRCOG's FOCUS 2040 model that were provided as a series of MS Excel files to the roadway network that was provided as an ArcGIS shapefile. Unique numeric identifiers in each dataset allowed us to attach the traffic volume and speed data from the FOCUS 2040 model results to the corresponding network links that contained the necessary roadway segment location, distance and grade information. We then assigned per-vehicle-mile $PM_{2.5}$ emission rates from the $PM_{2.5}$ lookup table to each network link based on each link's grade, average speed and roadway type (either controlled urban restricted access or urban unrestricted access). The $PM_{2.5}$ emission rates were then

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[22] The input file does not contain the required meteorological data. These data are contained in two additional files that AERMOD reads when it runs.

[23] Note, for reasons not explained in any documentation provided by CDOT, seven receptors referred to by CDOT as "supplemental receptors" were modeled with a separate set of AERMOD input and output files – one for each of these seven receptors. The input files for each of these seven receptors contained altered volume source parameter settings (release height values) for some roadway segments that differ from the release heights prescribed in EPA's modeling guidance.

[24] "The 24-hour primary and secondary PM2.5 standards are met when the 98$^{th}$ percentile 24-hour concentration, as determined in accordance with appendix N of this part, is less than or equal to 35 [mu]g/m3." 40 C.F.R. §50.13(c). 71 Fed. Reg. 61,143, 61,224 (Oct. 17, 2006). Appendix N defines the "design value" as "the metrics (i.e., statistics) that are compared to the NAAQS levels to determine compliance, calculated as shown in [ ] this appendix." 40 C.F.R. Part 50, Appendix N, 1.(c).

multiplied by the traffic volume and distance of each roadway segment to estimate the quantity of $PM_{2.5}$ emissions for each roadway segment for each time period[25].

Next, we estimated $PM_{2.5}$ emissions from re-suspended roadway dust for each roadway segment for each time period. First, we estimated $PM_{2.5}$ emission rates for roadway dust from the table of $PM_{10}$ roadway dust emission factors provided by CDOT. Using the ratio of $PM_{2.5}$ to $PM_{10}$ for roadway dust emissions provided in AP-42[26], $PM_{2.5}$ roadway dust emission factors were calculated as one quarter of the value of CDOT's $PM_{10}$ roadway dust emission factors. We then assigned the per-vehicle-mile roadway dust $PM_{2.5}$ emission factors to each roadway segment based on the type of roadway ("general freeway", "freeway HOT or managed lanes", or "ramps"). The roadway type for each roadway segment was provided in the transportation network files provided by CDOT. Following the methods used for the agencies' hot-spot analysis, we assumed the Project was in an "urban" area. The roadway dust $PM_{2.5}$ emission rates were then multiplied by the traffic volume and distance of each roadway segment to estimate the quantity of roadway dust $PM_{2.5}$ emissions for each roadway segment for each time period. Finally, we added the emissions from vehicle exhaust, tire wear, and break wear (from MOVES) to the roadway dust emissions to estimate the total quantity of $PM_{2.5}$ emissions from vehicle traffic for each roadway link for each time period.

In the final step, we edited the AERMOD input files provided by CDOT to replace $PM_{10}$ emissions with $PM_{2.5}$ emissions for each volume source and to instruct AERMOD to report the appropriate design values for a $PM_{2.5}$ hot-spot analysis (the 1$^{st}$ highest and the 98$^{th}$ percentile concentrations at each receptor[27]). Seven "supplemental" receptors were modeled in seven separate modeling runs for the $PM_{10}$ hotpot analysis[28]. These supplemental modeling runs contained different emission source release heights than the primary modeling run that included the other 3,525 receptors. For the $PM_{2.5}$ hotspot analysis SSR added the seven supplemental receptors to the primary AERMOD input file so that all receptors would be modeled using the same set of input parameters. We believe that this approach is the most consistent with U.S. EPA Hotspot Modeling guidance, especially given that no justification was provided in the I-70 Project modeling files or reports for the changes made to the release heights for a small subset of the receptors. All other inputs remained unchanged.[29]

Each volume source has an alphanumeric identifier in the AERMOD input files that define groups of volume sources that correspond with a segment of roadway. The volume sources also have x and y UTM coordinates defining their location. The roadway network provided by CDOT did not contain information to match roadway segments to the alphanumeric identifiers for each volume source. Therefore, to update the volume sources with $PM_{2.5}$ emissions calculated for each segment we plotted the location of each volume source group in ArcGIS and spatially matched them to the roadway network segment that they overlaid. For each roadway segment we then divided its total $PM_{2.5}$ emissions by the number of volume sources matched to it and assigned the resulting quantity of $PM_{2.5}$ emissions to each of the spatially matched volume sources (i.e., each volume source that corresponds to a roadway segment has an equal portion of the segment's total emissions). AERMOD takes as input gram per second emission rates for up to 24 one-

[25] Note that CDOT estimated a separate emission lookup table for heavy-duty truck traffic and all other vehicle traffic (e.g., passenger cars, pickup trucks, vans, etc.) The DRCOG model also estimated the volume of all traffic and separately the volume of heavy-duty truck traffic. SSR followed the same process. The emission calculation process described here applies to the calculation of emissions from both types of vehicles. The quantity of emissions from each vehicle type on each segment are combined before moving onto the dispersion modeling process.
[26] See Table 13.2.1-1 in US EPA, *AP 42, Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources*.
[27] The 1$^{st}$ highest 24-hour concentration is required to calculate the design value using EPA's 2010 Hotspot Guidance while the 98$^{th}$ percentile concentration is required to calculate the design value using EPA's 2015 Hotspot Guidance.
[28] See SSR's March 7, 2018 "Report of Investigation of Receptor Locations Selected for Modeling Emissions of PM10 From the I-70 Project" for a more detailed analysis and discussion of the "supplemental" receptors.
[29] We also used the same meteorology data inputs covering the same time periods as CDOT. We obtained these from the APCD

hour time periods each day. The AERMOD inputs provided by CDOT contained 12 time periods of varying lengths, some of which did not align with the time periods from the FOCUS 2040 traffic outputs. SSR calculated time weighted average emission rates for AERMOD time periods that contained more than one FOCUS 2040 time period[30]. We then ran AERMOD version 15181 with the updated input file.

# 3 PM2.5 MODELING RESULTS

The following section provides results of the hot-spot analysis for $PM_{2.5}$ based on the modeling process described in the prior section and a design value calculation based on background concentrations obtained from air quality monitors in the same location as that used in the agencies' hot-spot analysis.

## 3.1 Modeled Concentration of PM2.5 Emissions from Vehicle Traffic

The modeling estimates the average 24-hour concentrations of $PM_{2.5}$ caused by emissions from the Project at each receptor location for the 1st highest day (i.e., the most polluted 24 hour period) and the 8th highest day (i.e., the 8th most polluted 24-hour period which is the 98th percentile 24-hour period in a set of 365 such periods). The 98th percentile $PM_{2.5}$ concentrations estimated by SSR for each receptor location defined in the agencies' prior $PM_{10}$ hot-spot analysis for the I-70/I-25 interchange area (Figure 1) and the I-70/I-225 area (Figure 2) are shown in the maps below. The concentration patterns are similar to those estimated by the agencies for $PM_{10}$. Concentrations at the I-70/I-25 interchange are generally higher than those at I-70/I-225 and the highest concentrations are located immediately southeast of the I-70/I-25 interchange. The pattern of concentrations for the 1st highest concentrations are similar to the 98th percentile concentrations shown in these figures.

[30] In general, this was accomplished by dividing each roadway segment's total emissions for each time period by the number of seconds in that time period. Some time periods defined in the AERMOD input file were a combination of more than one of the time periods reported in the FOCUS 2040 outputs. In some cases, the AERMOD time periods were a fraction of one or more of these time periods. In these situations, emissions for the volume sources reflect time weighted gram per second emissions from one or more of the FOCUS 2040 time periods.

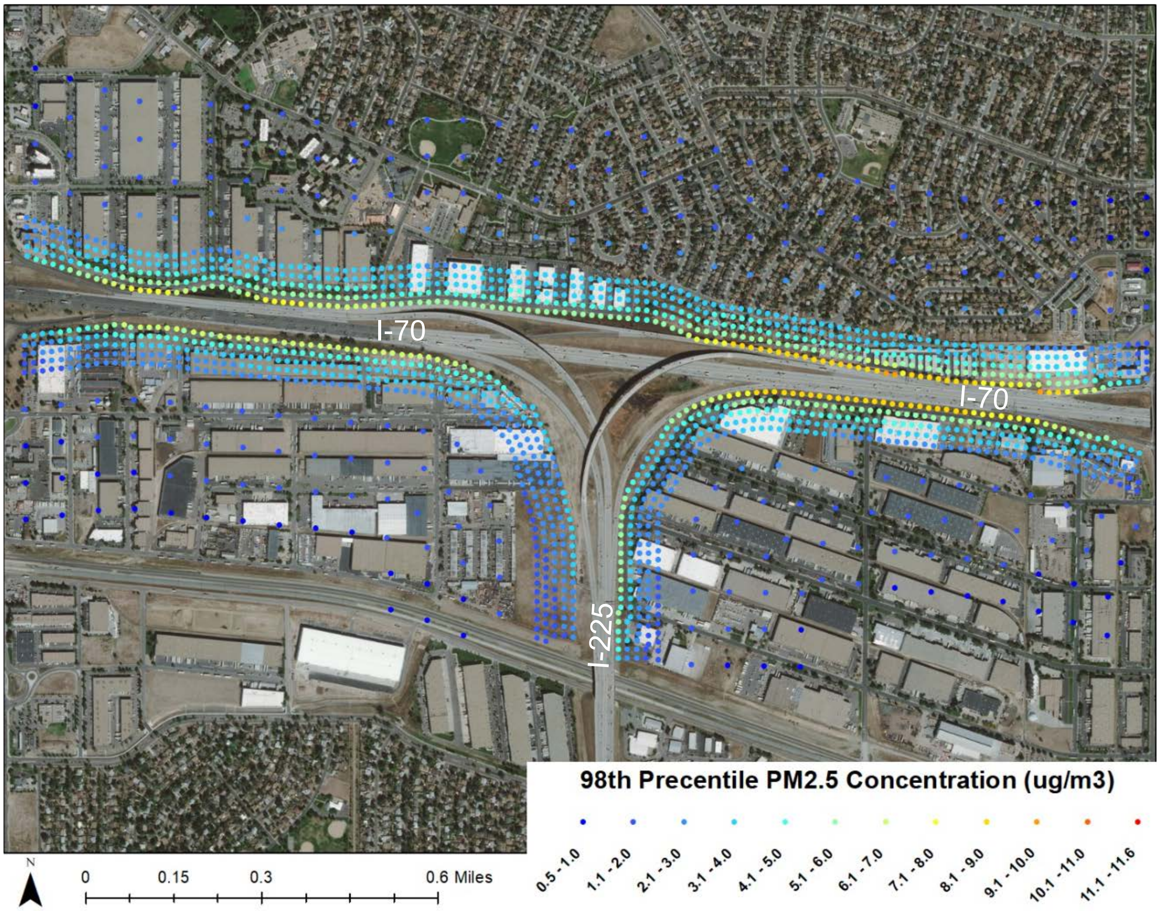


**Figure 1 I-70/I-225 Interchange: 98th Percentile PM2.5 Concentrations from Vehicle Traffic on Phase I of the I-70 East Project (µg/m³)**

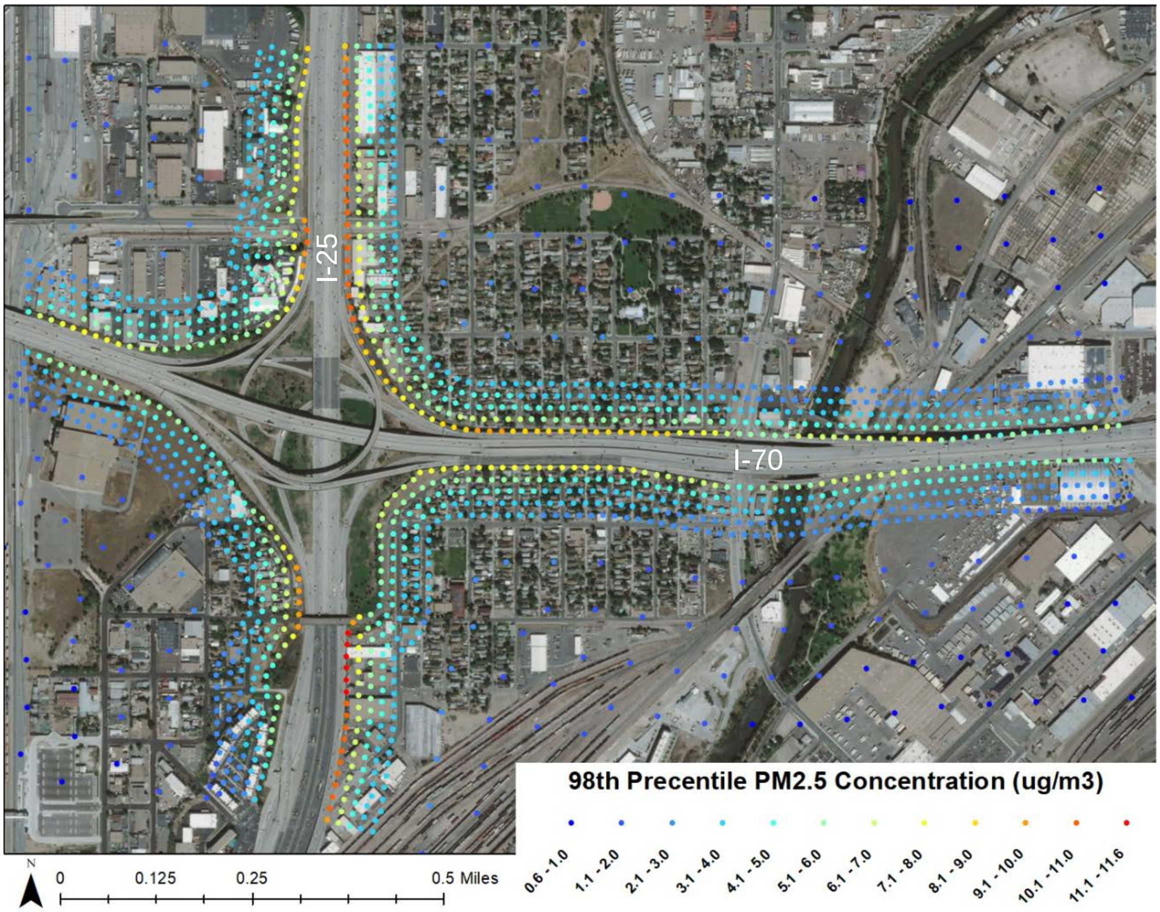


**Figure 2. I-70/I-25 Interchange: 98th Percentile PM2.5 Concentrations from Vehicle Traffic on Phase I of the I-70 East Project (µg/m³)**

The highest 1st highest 24-hour concentration is 14.6167 µg/m³ (receptor located at UTM coordinates: 500952.8278, 4402905.673) and the highest 98th percentile 24-hour concentration is 11.64613 µg/m³ (receptor located at UTM coordinates: 500952.8278, 4402905.6726). Figure 3 shows the location and concentrations of the receptors with the highest 24-hour concentrations which are also located near the maximum concentration receptors. It should be noted that all but one of these receptors are located outside the Project right-of-way in parking lots to which the public has access. EPA requires that receptors have regulatory significance for determining NAAQS compliance only if located in the "ambient air." EPA defines "ambient air" as "that portion of the atmosphere, external to buildings, to which the public has access." 40 C.F.R. § 50.1(e).

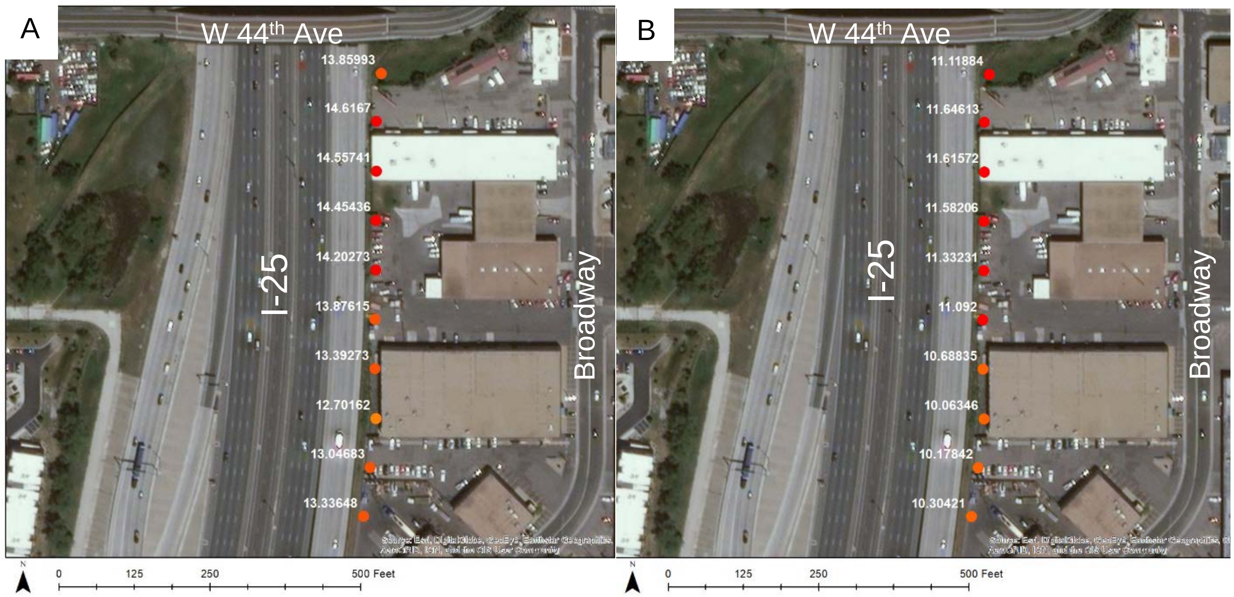


**Figure 3 Receptors with the highest 1st highest (A) and highest 98th percentile (B) $PM_{2.5}$ concentrations ($\mu g/m^3$)**

## 3.2 Design Value Calculation

To estimate a design value for a proposed transportation project that can be compared to the 24-hour $PM_{2.5}$ NAAQS U.S. EPA requires that $PM_{2.5}$ concentration contributed by emissions from the project be added to the background $PM_{2.5}$ concentration in the study area. U.S. EPA has issued two different procedures for determining the "design value" of a transportation project for comparison with the $PM_{2.5}$NAAQS. Both procedures require that expected future concentrations resulting from Project emissions be added to background concentrations to determine the "design value". The method for calculating background concentrations is the same for both procedures. But EPA's initial design value procedure issued in 2010[31] requires that the highest 24-hour concentration contributed by the Project be added to background, whereas the procedure issued in 2015 requires that the 98th percentile $PM_{2.5}$ concentration from the Project (8th highest 24-hour concentration) be added to background.

### *3.2.1 Background Concentrations*

Background concentrations are typically obtained from a nearby air quality monitor. U.S. EPA guidance requires that three years of monitoring data be used to estimate a background design value.

The agencies' $PM_{10}$ hot-spot analysis used monitoring data for the years 2012-2014 from the Alsup monitor (Site ID: 080010006) located about 4 miles northeast of the I-25/I-70 interchange by the intersection of state routes 224 and I-76 (Figure 4). The Alsup monitor also measures $PM_{2.5}$; however, only 2 years (2013 and 2014)[32] of valid 24-hour measurements were collected at the Alusp site before the site was re-located. A new monitoring site called Tri County Health (Site ID: 080010008) began operation in July 2016 within approximately 500m from the Alsup monitor site (see Figure 4). The Tri County Health monitor collected a full year of 24-hour $PM_{2.5}$ measurements during 2017.[33] The three-year background 98th percentile $PM_{2.5}$ concentration used to calculate the design values presented in this report are obtained from the three years

[31] Hot-spot Guidance

[32] According to a review of US EPA's 2016 Design Value Report: https://www.epa.gov/air-trends/air-quality-design-values

[33] Values downloaded from US EPA Monitor Values Report website on 2/15/2018: https://www.epa.gov/outdoor-air-quality-data/monitor-values-report. A note is included with these data states they will not be final until May 1st, 2018.

of data available from the locale of the monitor used for $PM_{10}$ hotspot analysis: 2013-2014 values from Alsup and 2017 values from Tri County Health. These three annual background concentrations are from the location most similar to the monitoring location used to determine background for the $PM_{10}$ hotspot analysis. At this location the 3-year mean 24-hour concentration is 25 µg/m$^3$.

Three years of consecutive data from 2014-2016 are available from the La Casa monitor (Site ID: 080310026) located approximately 0.8 miles southwest of the I-25/I-70 interchange (Figure 4). However, this site was considered by the agencies but not chosen for the $PM_{10}$ emissions analysis because Air Pollution Control Division staff concluded that nearby land-uses (lack of proximity to industrial sources that affect air quality at the Project site), different prevailing wind patterns, and elevation of the monitor above the Platte Valley floor (where the Project is located) made it less representative of background air quality in the Project area than the Alsup monitor.[34] At the La Casa monitor the 3-year mean 24-hour concentration is 21 µg/m$^3$. However, these data are not used for estimating background concentrations because they likely underestimate the Project area's background $PM_{2.5}$ concentration for the reasons identified by APCD.

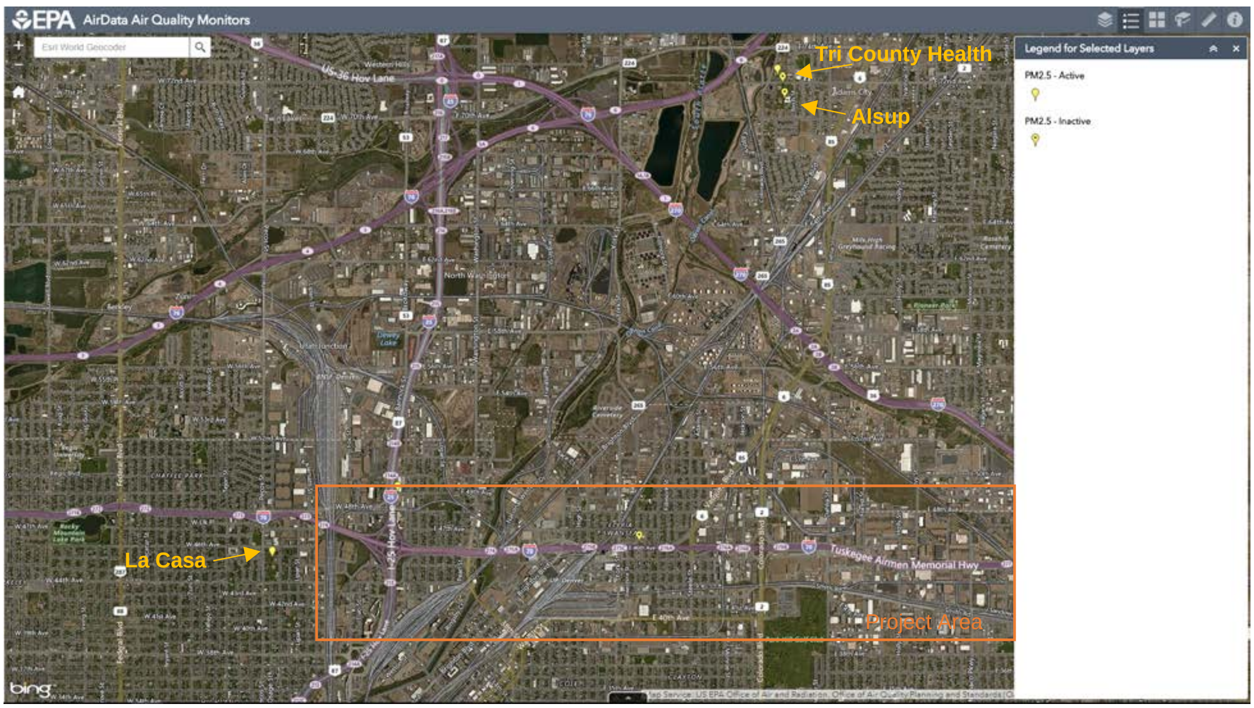


**Figure 4 US EPA PM2.5 Air Quality Monitors**[35]

### *3.2.2 Design Values*

SSR calculated design values using both the procedures in EPA's 2010 and 2015 conformity guidance.[36] The 98$^{th}$ percentile $PM_{2.5}$ concentrations from the most recent 3 years of complete data from the Alsup/Tri-

[34] Email responding to 11/17/16 request from CDOT for approval to use data from LaCasa monitor as background air quality for calculating the Project "design value"; From G. Pierce, Air Pollution Control Division, CDPHE, to V. Henderson, Colorado DOT, cc: FHWA (November 23, 2016): "we are having a hard time justifying the use of the La Casa site for background PM10 concentrations." Three reasons given. *See* Appendix B.

[35] Screen capture from: https://www.epa.gov/outdoor-air-quality-data/interactive-map-air-quality-monitors

[36] On April 12, 2016, Petitioners submitted a petition to U.S. EPA requesting on substantive and procedural grounds that EPA revoke the design value procedures in §§ 9.3.3 ($PM_{2.5}$) and 9.3.4 ($PM_{10}$) of EPA's Hot-Spot Conformity Guidance posted to a website in 2015 that amended and purported to replace the procedures published in EPA's 2010

County monitoring site were added to the modeled $PM_{2.5}$ concentrations from the Project (Table 1). The results indicate that the selection of an appropriate background $PM_{2.5}$ concentration is critically important to this analysis as well as which EPA guidance is used. Using measurements from the Alsup/Tri-County location results in a design value of 37 μg/m$^3$ using EPA's 2015 guidance and 40 μg/m$^3$ using EPA's 2010 guidance, either of which exceed the $PM_{2.5}$ 24-hour NAAQS.

**Table 1. $PM_{2.5}$ Background Concentrations (μg/m$^3$) and Calculated Design Value**[37]

| | Background Monitor $PM_{2.5}$ 98th Percentile Values | | | | | | Modeled $PM_{2.5}$ from Project | | $PM_{2.5}$ Design Value | |
|---|---|---|---|---|---|---|---|---|---|---|
| Site | 2013 | 2014 | 2015 | 2016 | 2017 | 3-Year Mean | Highest 8th Highest | Highest 1st Highest | 2010 Guidance | 2015 Guidance |
| Alsup | 23 | 28.2 | | | | 25 | 11.6461 | 14.6167 | 40 | 37 |
| Tri County Health | | | | | 23.7 | | | | | |

## 4 CONCLUSIONS

SSR performed an air quality hot-spot analysis for Phase I of the I-70 East Project to evaluate the effect of vehicle traffic on the concentration of $PM_{2.5}$ in the Project area and evaluate the potential for the Project to cause a violation of the 24-hr $PM_{2.5}$ NAAQS. Our analysis used the same data and methods as the agencies' hot-spot analysis, with the only changes being those required to model $PM_{2.5}$ rather than $PM_{10}$.Our analysis finds that the Project will significantly impact $PM_{2.5}$ concentrations in the Project area.$PM_{2.5}$ emissions from the Project would cause a violation of the NAAQS if air quality monitoring data from the Alsup/Tri-County monitoring location are representative of the Project area's background $PM_{2.5}$ concentration. The results indicate the Project contributes significantly to increased concentrations of $PM_{2.5}$ in the Project area.

It is important to note that this analysis only considers emissions from Phase I of the I-70 East Project and reported current background concentrations. Other potential increases in $PM_{2.5}$ emissions from sources present in the study area or that may occur in the future, including additional traffic when the entire I-70 East Project is completed, are not considered.

Hot-spot Guidance. EPA has yet to act on that petition. Until EPA acts on that petition, Petitioners in this proceeding contend that the provisions of EPA's 2010 Hot-spot Guidance continue to apply. Therefore for the purpose of this hot-spot analysis the results are reported for both procedures.

[37] Alsup $PM_{2.5}$ data from US EPA's 2016 Design Value Report: https://www.epa.gov/air-trends/air-quality-design-values. Tri County Health $PM_{2.5}$ data from US EPA Monitor Values Report website: https://www.epa.gov/outdoor-air-quality-data/monitor-values-report

## APPENDIX A

MS Excel file "I70 Road Dust EFs—Final.xlsx" provided by CDOT to the Sierra Club

**Road Dust/Sanding Factors for I-70 Analysis**

General calculation of emission factor:

cntrldEF(grams/mile):
(IIf([RoadDustFactors]![class]<>8,(1)*0.0896*1.76*0.937*(1-[sweep box reduction]),0)) (sanding factgor)
+((1)*([factor(grams/mile)]-[PM10_89])*(1-[sweep box reduction])*0.937) (road dust factor)

**I-70 project factors**

| | | | | | **EF by Area Type, gm/mi** | | |
|---|---|---|---|---|---|---|---|
| Class | Name | Agency | Control | Reduction | AT2 | AT3 | AT4 |
| 1 | General Freeway | CDOT | sweepbox | 83% | 0.106835 | 0.105497 | 0.105736 |
| | Frwy HOT/managed lanes | CDOT | sweepbox | 75% | 0.157111 | 0.155143 | 0.155494 |
| 2 | Maj. Regional | Denver | GPMD | 60% | 0.251377 | 0.248229 | 0.248791 |
| 3 | Pr. Arterial | Denver | GPMD | 60% | 0.356321 | 0.353173 | 0.353735 |
| 4 | Min. Arterial | Denver | GPMD | 60% | 0.689893 | 0.686745 | 0.687307 |
| 5 | Collector | Denver | GPMD | 60% | 0.688019 | 0.684871 | 0.685433 |
| 6 | Ramps | CDOT | sweepbox | 83% | 0.129136 | 0.127798 | 0.128037 |
| 7 | Frontage | Denver | GPMD | 60% | 0.523107 | 0.519959 | 0.520521 |
| 8 | Local | Denver | GPMD | 60% | 0.686145 | 0.682997 | 0.683559 |

*GPMD=General PM10 Modeling Domain (non-sweepbox)

7/28/16: Denver reduction changed from 42% to 60% based on most recent DRCOG conformity commitment.
8/2/16: CDOT reduction revised to reflect 75% reduction on HOT/managed lanes

**RoadDustFactors**

| class | name | factor gm/mi |
|---|---|---|
| 1 | Freeway | 0.64 |
| 2 | Maj. Regional | 0.64 |
| 3 | Pr. Arterial | 0.92 |
| 4 | Min. Arterial | 1.81 |
| 5 | Collector | 1.805 |
| 6 | Ramps | 0.78 |
| 7 | Frontage | 1.365 |
| 8 | Local | 1.8 |

**Area Type PM10_89 correction**

| code | areatype | correction |
|---|---|---|
| 1 | CBD | 0.1512 |
| 2 | Fringe | 0.127 |
| 3 | Urban | 0.1354 |
| 4 | Suburban | 0.1339 |
| 5 | Rural | 0.1368 |

**Emissions Reduction**

| Agency | Strategy | Reduction |
|---|---|---|
| CDOT: HOT/managed | Sweep Box | 0.75 |
| CDOT: other freeway | Sweep Box | 0.83 |
| Denver | GPMD | 0.6 |

**APPENDIX B**

**EMAIL EXCHANGE BETWEEN CDOT AND APCD REGARDING BACKGROUND MONITOR**

AR 29381-29383

On Thursday, November 17, 2016, Henderson - CDOT, Vanessa <vanessa.henderson@state.co.us > wrote:

Hi Gordon -

I left you a voicemail at the end of the day yesterday and wanted to follow-up on that because FHWA just had another call with EPA this morning. EPA has indicated that they would be okay with us switching background monitors from the old Commerce City monitor to the newer La Casa monitor as long as APCD is okay with it. If you're able to confirm that APCD is okay with it, that'd be great. Here's the information that we provided to EPA about why the La Casa monitor would be better for this project (as a refresher for you from the recent Cooperating Agency meeting).

At the time we began development of the air quality protocol for the I-70 East project in the summer of 2012, the La Casa site was not yet in operation, and we selected from the existing nearby monitors with 3 years of PM10 data (CAMP, Commerce City, and Welby) as potential sources of background concentrations. However, as we noted in the protocol, it may also be appropriate to use a different monitor, or interpolate between these and/or another monitor.The La Casa site began operation 9/27/2012, and it now has 3 complete years of PM10 data (2013-2015). It is located approximately 3/4 mile west of the I-25 interchange, which has the highest modeled concentrations (excluding background) anywhere along the project. (The Commerce City site ceased operation in 2015, so 2012-2014 data are the most recent available from this site, and it is located over 4 miles northeast of the I-25 interchange.) In addition to the La Casa data being newer and closer, APCD has indicated verbally that this monitor is more reflective of land use in the project area, and would provide a more representative background concentration than the Commerce City site that we are currently using. This in turn would result in more accurate design values for the PM10 conformity and NEPA analyses.

We propose to use this site as the source of background data for the revised PM10 hotspot analysis and conformity determination to be released for public review later this month. We would like to request your assistance in calculating the applicable 2013-2015 background value from this site (considering data completeness, as well as the multiple samplers present at this location). We will also prepare a technical justification for using this site as a source of background data (in consultation with APCD), addressing the factors outlined in section 8.3.1 of the PM hotspot guidance.

Also, EPA has requested the data from the La Casa monitor in order to help us determine the appropriate background concentration to use. So, I was hoping that you or one of your staff would be able to provide that information to me for them. I think I can pull it from your website, but it'd make me feel better getting the data from you guys just in case I didn't pull the right stuff.

0000029381

4

Is there anything else that we'd need from you guys in order to proceed with the La Casa monitor that I haven't noted? I'm wondering if our Stapleton met data set is still the appropriate set of met data of if Emmett would need to get us new met data. Also, anything else you guys can think of would be great to know.

Feel free to give me a call if you want to discuss anything or add whoever you think should be included from your group to this email. I'm not sure of everyone's roles still (I think Dale is MOVES, Emmett is met data, and Paul is the transportation liaison, but not sure of anyone else), so I figured I'd just start with you and go from there. As I'm sure you're aware, we're very tight on time (still need to get the conformity out for agency/public review at the beginning of December), so if you're able to get back to me pretty quickly, I'd really appreciate it.

Thanks in advance for your help with this!

Vanessa

CDPHE responded with reasons not to use the La Casa monitor::

7. AR 29379- 29455

Gordon Pierce (CDPHE) to CDOT, FHWA, 11/23/16

Vanessa,

Sorry for the delay. I have had staff look at the data and site locations and we are having a hard time justifying the use of the La Casa site for background PM10 concentrations, even though the site is closer to the Globeville-Elyria-Swansea (GES) area. The primary issues are:
1. La Casa is located on a little higher terrain outside of the Platte Valley, so wind flows related to sources can be different versus the Alsup/Commerce City site.
2. La Casa has little to no significant industrial activity nearby whereas the GES area does have nearby industrial activity, including Purina, Metro Denver Wastewater, Suncor Refinery and Xcel Cherokee.Alsup/Commerce City is downwind of these sources as well, so it better reflects the GES area.
3. The GES area has impacts from both I-25 and I-70, including the "mousetrap". Due to its topographically higher location to the west and wind patterns (see wind roses in our Annual Data Reports that show a predominant SW component) we do not believe that La Casa is fully picking up all the impacts from the existing highways.

We have looked at the continuous PM10 data from the near-road Globeville site at I-25 and 49th Avenue as well made comparisons to other sites. For Oct. 2015 - Sep. 2016, the Globeville 1st max 24-hour concentration at local temperature and pressure (LTP) conditions is 93 ug/m3, the 2nd max is 87 ug/m3. For standard temperature and pressure (STP) conditions to directly compare the the PM10 NAAQS, these concentrations would be roughly 20% higher, or about 110 and 105 ug/m3 respectively. So, the Globeville location is much more comparable to what was seen at Alsup/Commerce City. (Note: as these values are not from a reference or equivalent analyzer, we are reporting what comes from the instrument, which is at LTP, not STP conditions.)

**These data are in an attached file.**

I don't know how the Federal Highways calculations work, but keep in mind as well that the La Casa site operates every 3rd day, not every day, so that would also affect the values used.

I have attached the La Casa data for 2013-2015, as requested, including the 24-hour FRM every 3rd-day and the hourly data. Note that the hourly data were initially from a TEOM (which is an equivalent analyzer with data at STP), but changed to a GRIMM analyzer (which is not an equivalent analyzer so data are at LTP) in March 2015.